DEVELOPMENT OF A CASTOR BEAN SHELLER FOR THE ETHIOPIAN FARMER

Experiment Station Bulletin No. 25

የኢትዮጵያ ፡ ንጉሠ ፡ ነገሥት ፡ መንግሥት ፡ የእርሻና ፡ የሜካኒክ ፡ ኮሌጅ ።
Imperial Ethiopian College of Agricultural and Mechanical Arts

በኢትዮጵያና ፡ በአሜሪካ ፡ የተራድኦ ፡
ሥራ ፡ የእርሻ ፡ ትምህርት ፡ ድርጅት ።

ETHIOPIA-UNITED STATES COOPERATIVE
AGRICULTURAL EDUCATION PROGRAM

Oklahoma State University - U. S. A. I. D. Contract

DEVELOPMENT OF A CASTOR BEAN SHELLER FOR THE ETHIOPIAN FARMER

By:

SHIBBERU WOLDE MARIAM
Department of Agricultural Engineering Technology

Imperial Ethiopian College of Agricultural and Mechanical Arts
HAILE SELLASSIE I UNIVERSITY
P. O. Box 138, Dire Dawa - Ethiopia

DEVELOPMENT OF A CASTOR BEAN SHELLER FOR THE ETHIOPIAN FARMER

INTRODUCTION

Castor bean (Ricinus communis) is not a leguminous plant as the name implies. It belongs to the family **Euphorbiaceae.** This plant grows in warm temperate and tropical countries and has its origin either in India or Africa. Castor bean is found growing wild in Ethiopia and is also considered to be an indiginous plant.

The use of the castor bean for medical purposes dates back to many countries. However, its industrial demand both for war time and peace time use is only recent. Until quite recently castor bean had been considered an item of strategic importance only, but now its use in the manufacture of various products has made it a valuable item as a raw material. It is highly important in the manufacture of paints, all purpose grease, synthetic resins for bonding high-speed abrasives, high-speed cutting tool oils, hair tonics, lipsticks, face creams and many others.[1]

The oil from the castor bean possesses a unique property in that among all the vegetable oils and fats it is the only one that does not lose its viscosity at extremes of temperature.[2] This characteristic property has made it extremely valuable for military purposes. Thus it is used as a lubricant in jet engines; fluid in control of equipment like hydraulic brakes, shock absorbers, bomb bays and turrets, and retractable landing gears in airplanes; and absorb the recoil of the artillery.[3]

Prior to the Korean War the demand for the castor bean was very high and accordingly in 1948 the Ethiopian Government urged the farmers to produce castor beans on a larger scale. The few farmers who responded and produced castor beans under cultivation were faced with the problem of shelling the bean. Due to lack of a sheller of any kind at the time these farmers lost a great sum

---

[1] Denker, T. N., Jr.
Oil on Your Farm. Crops and Soils, 5:10-11. December 1952.
Jones, M. A.
Castor Bean Studies Enter New Stage as Need for Oil Grows. Chemurgic Digest, 16:4-7. October, 1957.

[2] Domingo, W. E.
Castor Bean in Agriculture and Industry. Chemuric Digest, 12:14-15, April 1953.

[3] Texas Slighted? Brownsville Mill for Crushing Castor Beans. Business Week, April 1943, p. 53-54.

of money. It was this incident that led the author to attempt the development of a castor bean sheller suitable for the Ethiopian farmer. It was only in 1960 that the plan of the author became a reality as a result of his developing a suitable sheller while in school in the United States of America. The work of the author during his stay in the United States is further discussed in this bulletin. The author later proceeded to further develop the sheller, that he developed in the United States, while teaching at the Jimma Agricultural Technical School.

PRESENT PROBLEMS OF THE ETHIOPIAN FARMER IN THE PRODUCTION OF CASTOR BEANS

Although the castor bean grows very well under various climatic conditions in Ethiopia, commercial scale production is practically insignificant. A few mechanized farmers produce castor beans to a limited extent within Ethiopia today. On the other hand the average Ethiopian farmer has not been motivated to produce the castor plant as a cash crop, except for the few trees he plants around his home. This is true even though the price obtained for the castor beans is very favourable.

The castor plant produces a characteristic fruit covered with spikes that are stiff at maturity. The seed (bean) is produced within a hull which very closely adheres to it (the seed) during the immature stage and gradually separates as maturity progresses. Depending upon the variety of the plant, the fruit breaks from the branch and falls to the ground at maturity with a possible formation of cracks to free a few seeds. On the whole a mechanical means to separate the seed and the capsule is quite necessary. Should a farmer intend to increase production of his crop, he definitely will be faced with the shelling of the bean. The present methods of threshing are beating the grain with a stick or trampling by oxen. These methods are of only limited success in shelling castor beans as the pressure required to free the seed from the hull can not be uniformly controlled, and furthermore there is no way to separate the free beans from unhulled fruit. This means that more damage will be done to the free beans and the price of the product will be curtailed as a result.[4]

The farmer will be handicapped in the production of castor beans unless he is provided with a sheller that he can use. Such

[4] Schoenleber, L. G. and W. M. Hurst
Performance of Castor Bean Hulling Plants. Ag. Eng. 33:708-710. November 1952.

a sheller is discussed in this material and it is hoped that the farmer will, as a result, be motivated to increase the production of the castor beans.

DEVELOPMENT OF A HAND-OPERATED SHELLER

With the Ethiopian farmer's needs in the way of a castor bean sheller as a guide, a hand-operated cylinder-concave-type sheller was designed and constructed by the writer while attending school in the United States. The availability of material in Ethiopia and the ease of construction directed the writer's choice for material and method of construction of this machine.

PROCEDURE:

A stump of pine wood was secured and made into a cylinder of 23* centimeters diameter and 43* centimeters in length (Fig. 1). After the rough bark was removed, the stump was mounted on the

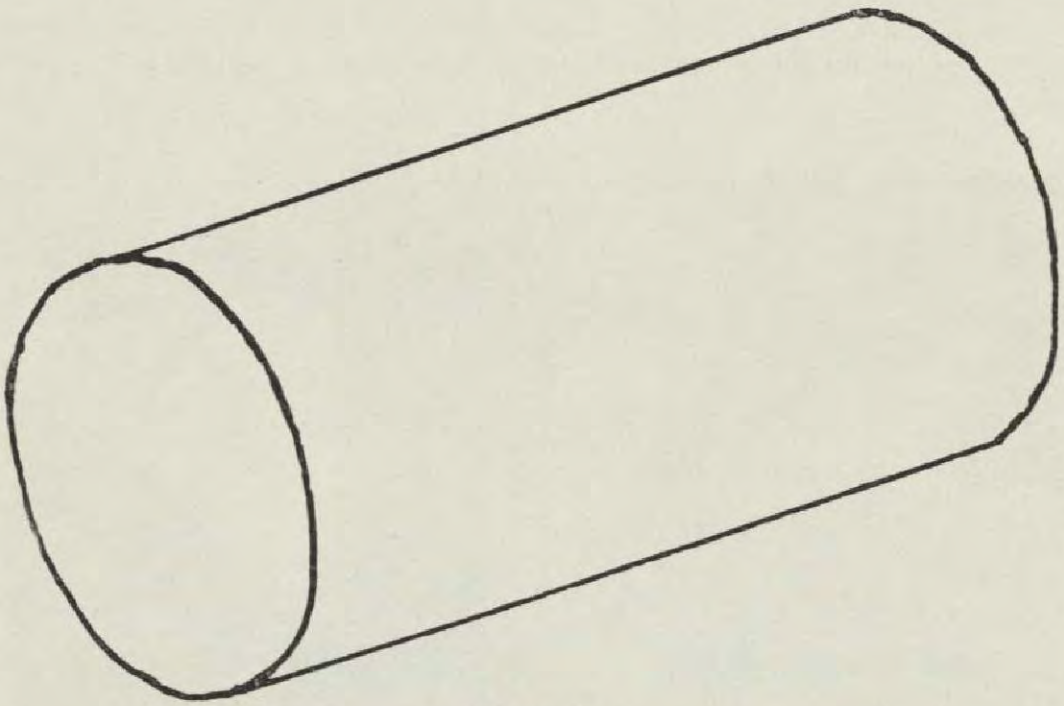


Figure 1.
The Cylinder.

* These figures were originally in inches and were transformed into the present unit of measurement.

lathe to smoothen the surface. Later four old automobile tires were secured and the middle portion of each tire was cut out (Fig. 2). This portion provided the rubber facing for the cylinder and concave. The facing was fastened to the cylinder and the concave by wood screws (Fig. 3).

Figure 2.
Removal of a middle portion of a tire with a hacksaw.

Figure 3.
Placement of the rubber facing on the cylinder.

The concave portion of the sheller was made out of a dimensional piece of lumber measuring 5 centimeters by 15 centimeters by 44 centimeters. A concave was constructed from pieces sawed out on the bandsaw. The pieces were then glued together to form the concave for the sheller (Fig. 4). The curvature was reduced at both ends of the concave to facilitate feeding of the fruit into the hulling area and the disposal of the material after hulling. This reduced curvature was necessary in order to provide more clearance between the cylinder and the concave at its (concave's) ends.

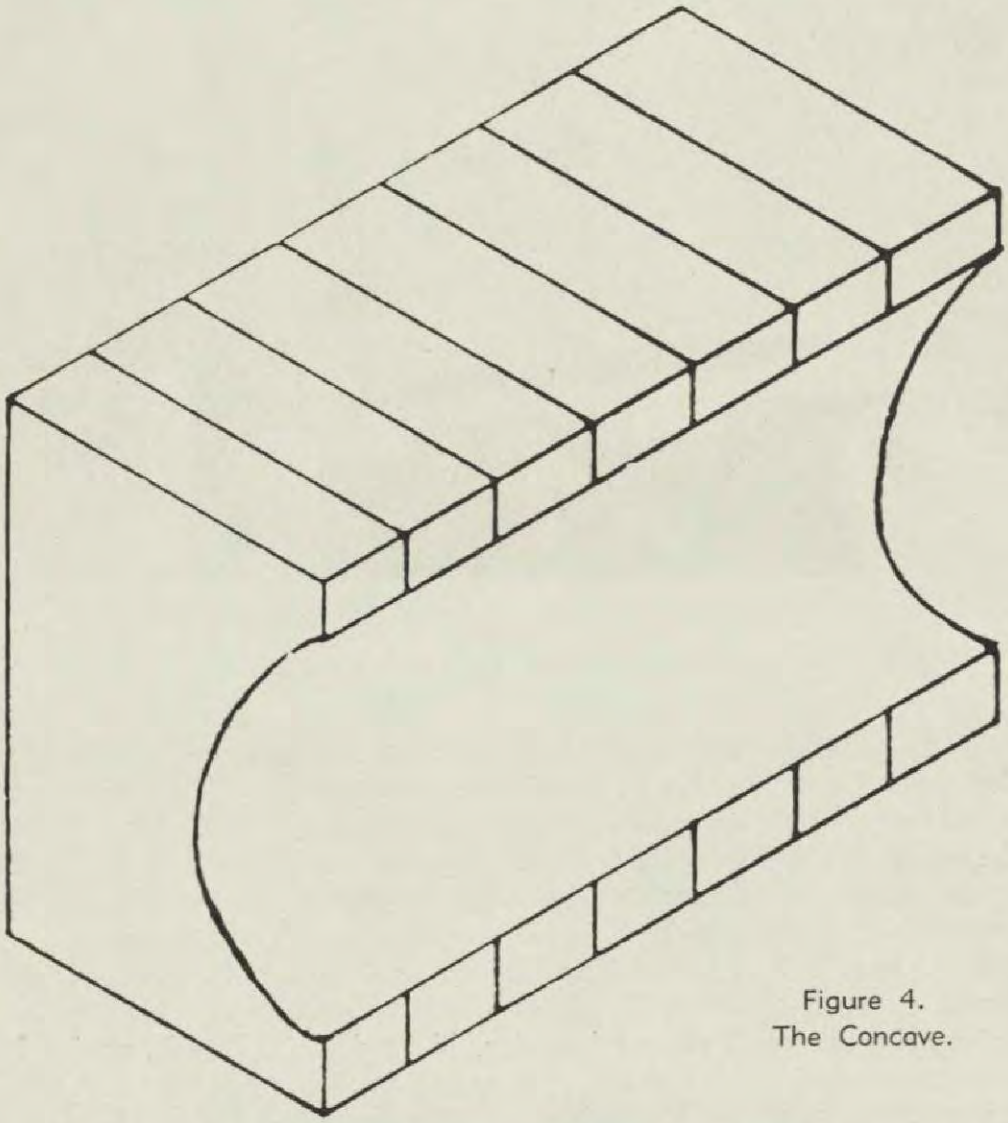


Figure 4.
The Concave.

A box-type hopper (feeder) wide at its top opening and narrow at its bottom opening was built from scrap lumber. It was mounted above the opening between the cylinder and concave attached to the upper end of the concave. The lower opening was made adjustable by a slide gate sliding up and down over the inside surface of one of the side walls of the hopper. A bolt fastened to the slide gate moves through a slot fixed at the upper end of the

wall on which the gate slides. The position of the gate is fixed by a nut on the bolt when the nut comes against the slot. If the gate is to be fully opened, the bolt is pulled up through the slot and the nut is screwed down against the slot. (Fig. 5).

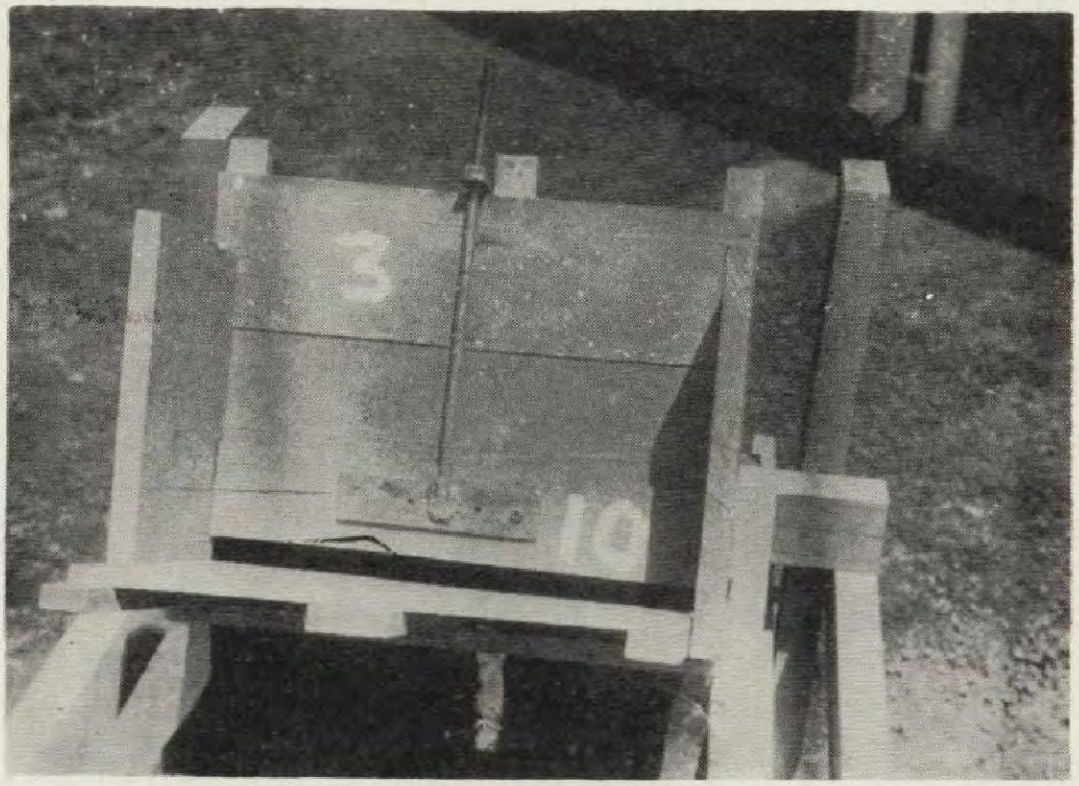


Figure 5.
The hopper (feeder) on the original sheller.

The sheller was provided with a mechanism to vary the clearance between the cylinder and the concave. This was made possible by the concave moving back and forth from the position of the cylinder. The concave was attached to a frame independently movable in relation to the support frame of the sheller. The former frame consisted of members numbered 13,4 (and its counterpart), and 5 (Fig. 6 and Fig. 7).Number 4 and its counterpart were made to slide between two vertical 5 centimeters by 15 centimeters dimensional pieces (as Nos. 11 and 12 in Fig. 8), and a bolt and pipe piece combination at each of the four corners of the support frame. Board No. 6 (Fig. 6) was nailed to the inside vertical framing members and a screw made out of 42 centimeters long and 1.5 centimeters diameter round stock with a handle (No. 8, Fig. 6) passed through it and board No. 5. A nut was welded to a metal strap iron (No. 7) which was later bolted to board No. 6. A similar metal strap iron was bolted to board No. 5. However, a nut was welded to the bolt at a position close to this metal strap iron. Two nuts (one a lock nut) were screwed on the bolt from its

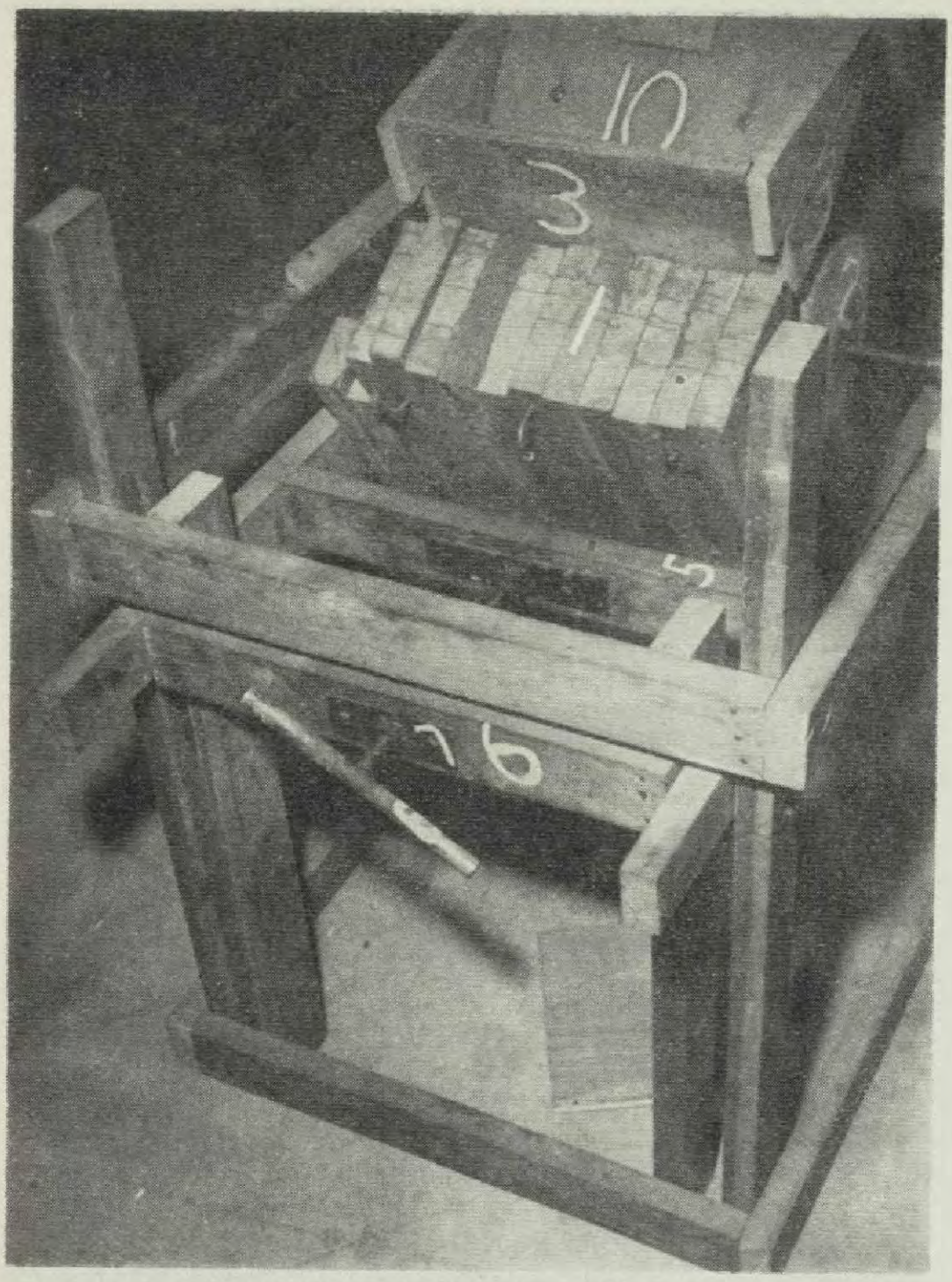


Figure 6.
Rear view of the sheller showing the different parts. 1. The concave constructed out of pieces of lumber glued together. 2. Portion of the cylinder. 3. Hopper attached to the concave. 5. A 5x10x62 centimeter horizontal spacing member as part of the slide frame to which the concave was attached. 6. A 5x10x59 centimeter dimensional lumber nailed to the inside framing members and showing the concave adjusting screw. 7. A metal strap iron bolted to board No. 6 and showing the nut welded to it to provide longitudinal movement of the screw. 8. Handle welded to adjusting screw made from 1.5 centimeter round stock. 10. The slide gate that controls the bottom opening of the hopper.

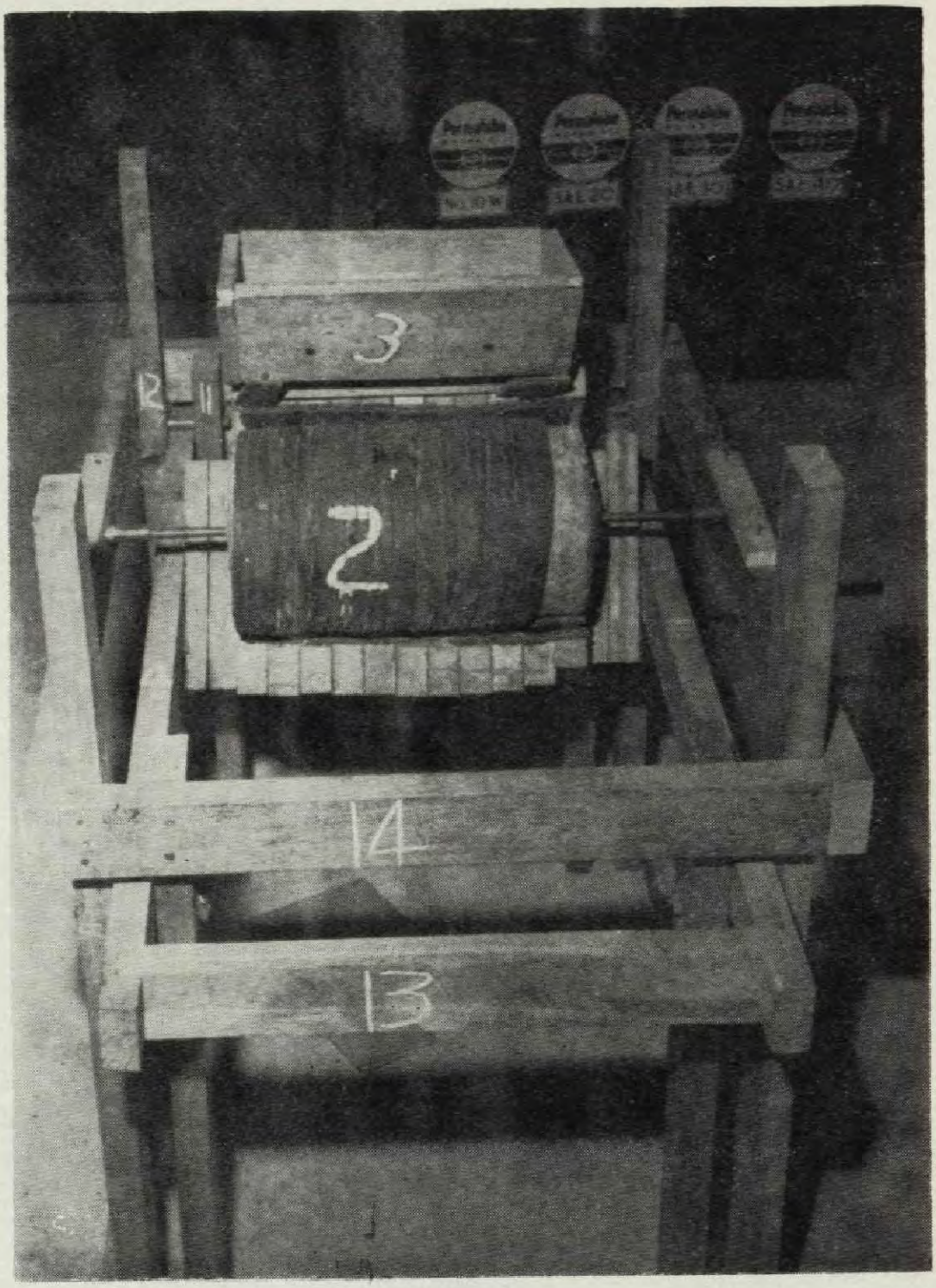


Figure 7.

Front view of the sheller. 2. The cylinder. 3. The hopper. 4. A 5x10x 152 centimeter concave adjusting member slide board with its counterpart shown in the right-hand portion of the picture. 11 and 12. 5x10x91 centimeter vertical framing members showing the upper bolt passing through them with a pipe spacer fitting over the bolt to facilitate the sliding of the concave adjusting member. 13. 5x10x62 centimeter dimensional piece of lumber holding the concave adjusting members together. 14. 5x10x76 centimeter dimensional piece of lumber that is part of the support frame.

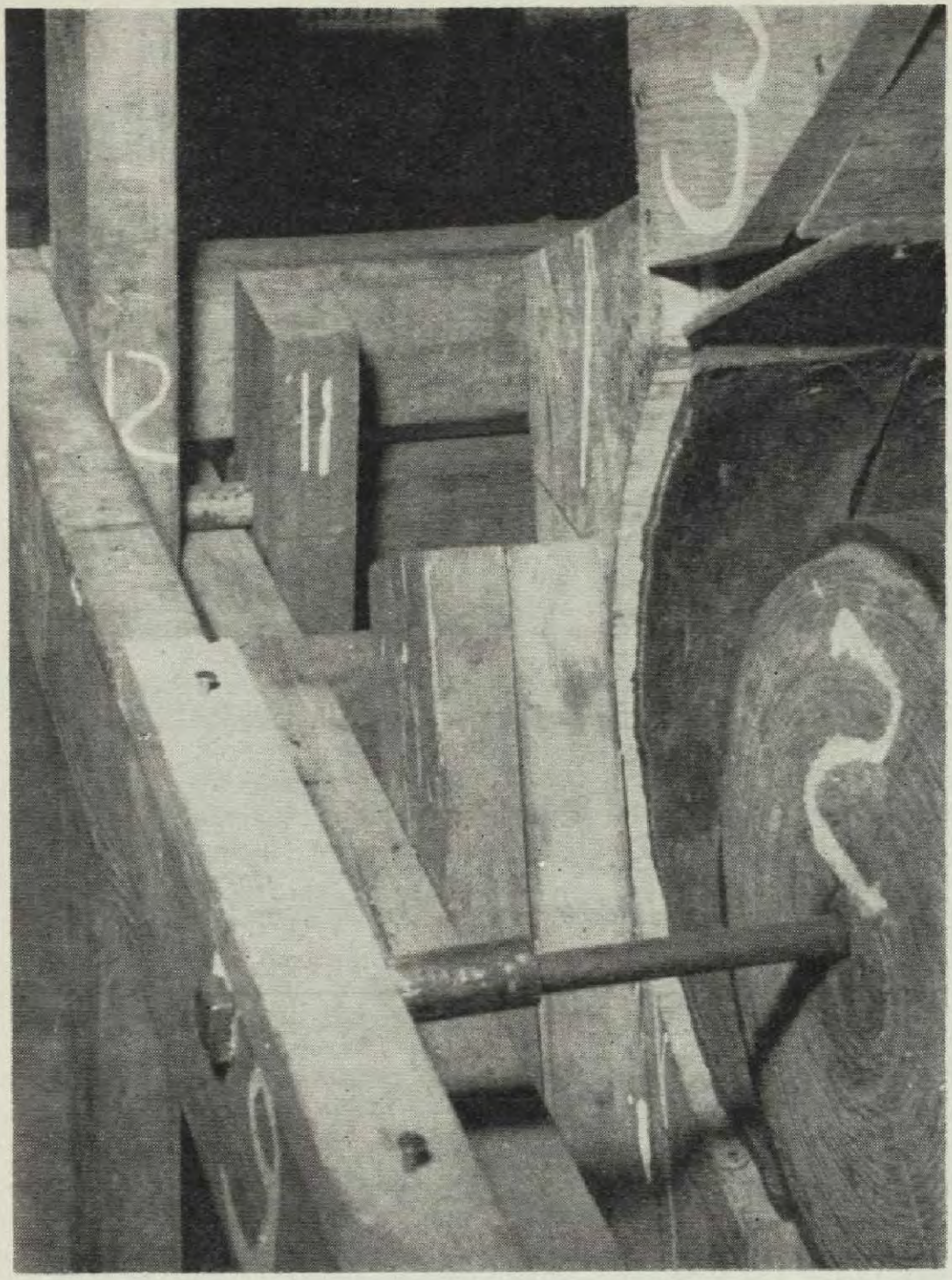


Figure 8.

An angular view of the sheller showing particular details. 1. The concave showing the reduced curvature at its top end. 2. The cylinder with drive shaft. 3. The hopper. 9. A 5x10x122 centimeter framing member which is part of the support frame. 11 and 12. Vertical 5x10 centimeter framing members showing the concave adjusting member passing between them.

free end until they were almost against board No. 5 (opposite the side on which the metal strap iron was mounted). These nuts pushed against board No. 5 whenever the handle of the bolt was turned counterclock wise (Fig. 9)**. By this means it was possible to increase the clearance between the concave and the cylinder (Fig. 10 and Fig. 11). On the other hand, whenever the handle of the bolt was turned clock wise, the nut that was welded to the bolt provided a force against the metal strap iron bolted to board No. 5. This action made it possible to decrease the clearance between the cylinder and the concave. In general, the bolt was made to screw in and out of the nut welded to metal strap iron No. 7 (Fig. 6). In this way the force on board No. 5 from either direction was made possible, thereby facilitating the back or front movement of the concave in relation to the cylinder.

** Fig. 9 - Refer to plans on last page.

TEST AND RESULTS:

Four samples of size 100 capsules (fruit) were taken from a bag of castor beans. Each sample was run through the sheller and a count of the clean beans, segments, broken or cracked beans and fruit was taken (Fig. 12)* This was later reduced to a percentage basis. The result of the test was summarized as in Table I. It was found that the huller had an efficient of 86.5 per cent.

TABLE 1. - Results of the hulling test on the castor bean sheller.*

Number of tests	Broken or checked beans (per cent)	Unhulled fruit (per cent)	Segments (per cent)	Hulled beans (clean seed) (per cent)
1	2	None	12	86
2	3	None	9	88
3	5	1	8	86
4	5	None	9	86
Average	3.75	0.25	9.5	86.5

* Shibberu Wolde Mariam.
Development of a castor bean sheller for the Ethiopian farmer. A Master's Report, Kansas State University. January 1960, p. 18.

* Each heap shown in Figure 12 was not necessarily meant to indicate the relative proportion of the products after shelling the four samples. The fruit was included to clarify the terminology used.

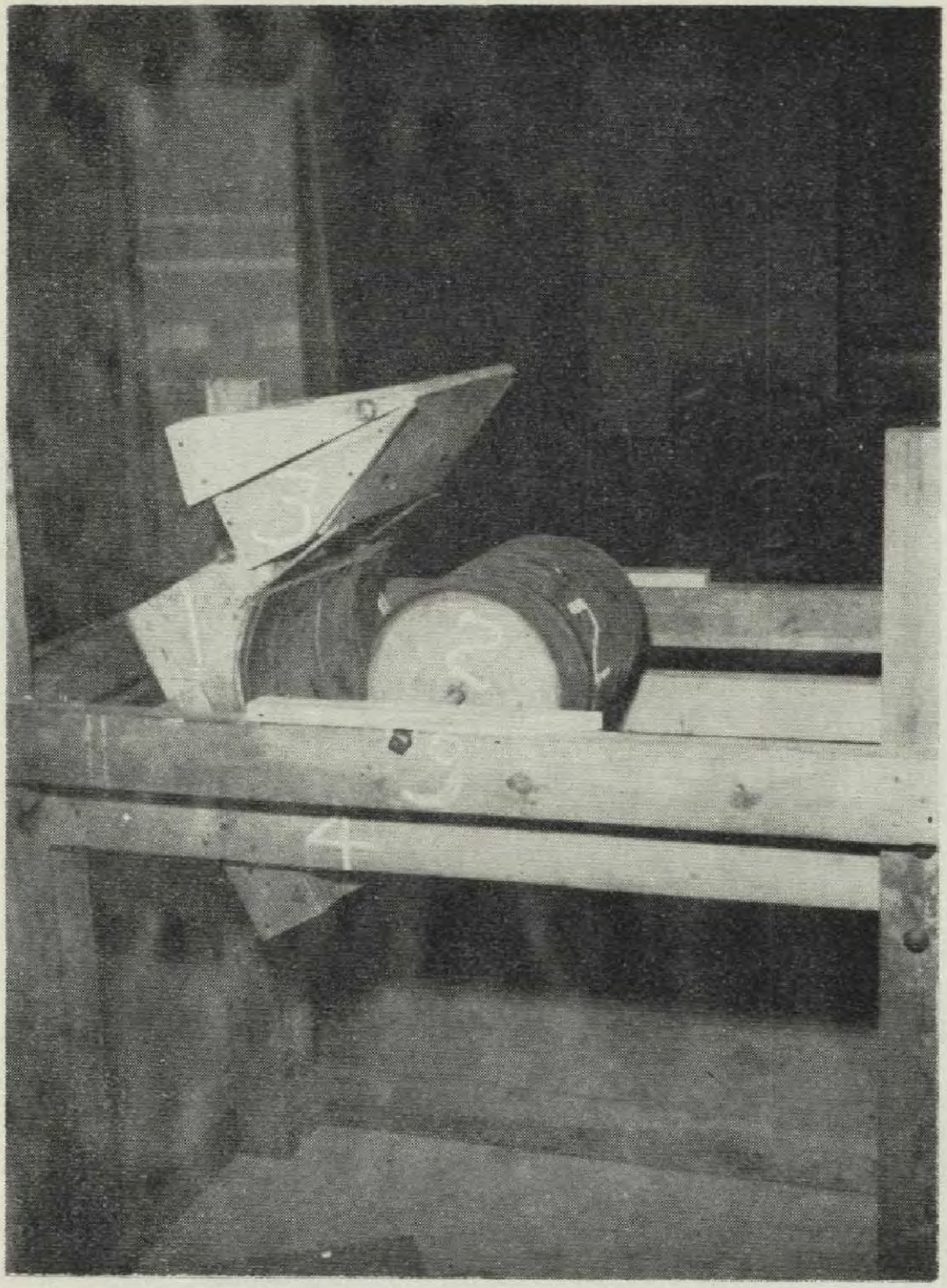


Figure 10.

Another view of the sheller showing particularly the relationship of the cylinder and concave with small clearance between them. 1. Concave. 2. Cylinder. 3. Hopper. 4. Concave adjusting member. 9. A dimensional piece as part of the support frame showing the drive shaft supported by it.

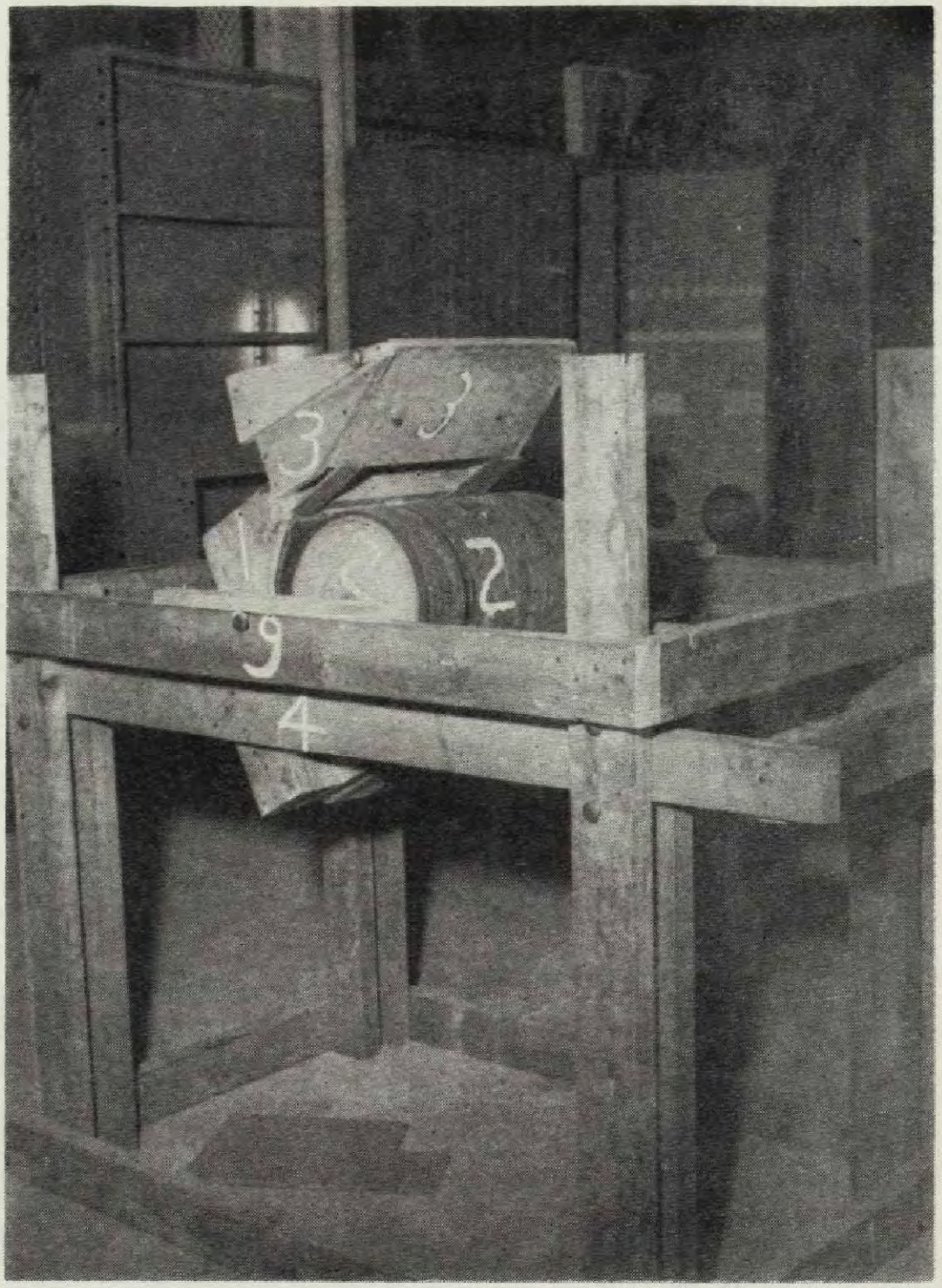


Figure 11.

Side view of the sheller showing the increased clearance between the concave and cylinder. 1. Concave. 2. Cylinder. 3. Hopper. 4. Concave adjusting member. 9. Dimensional piece as a part of the support frame.

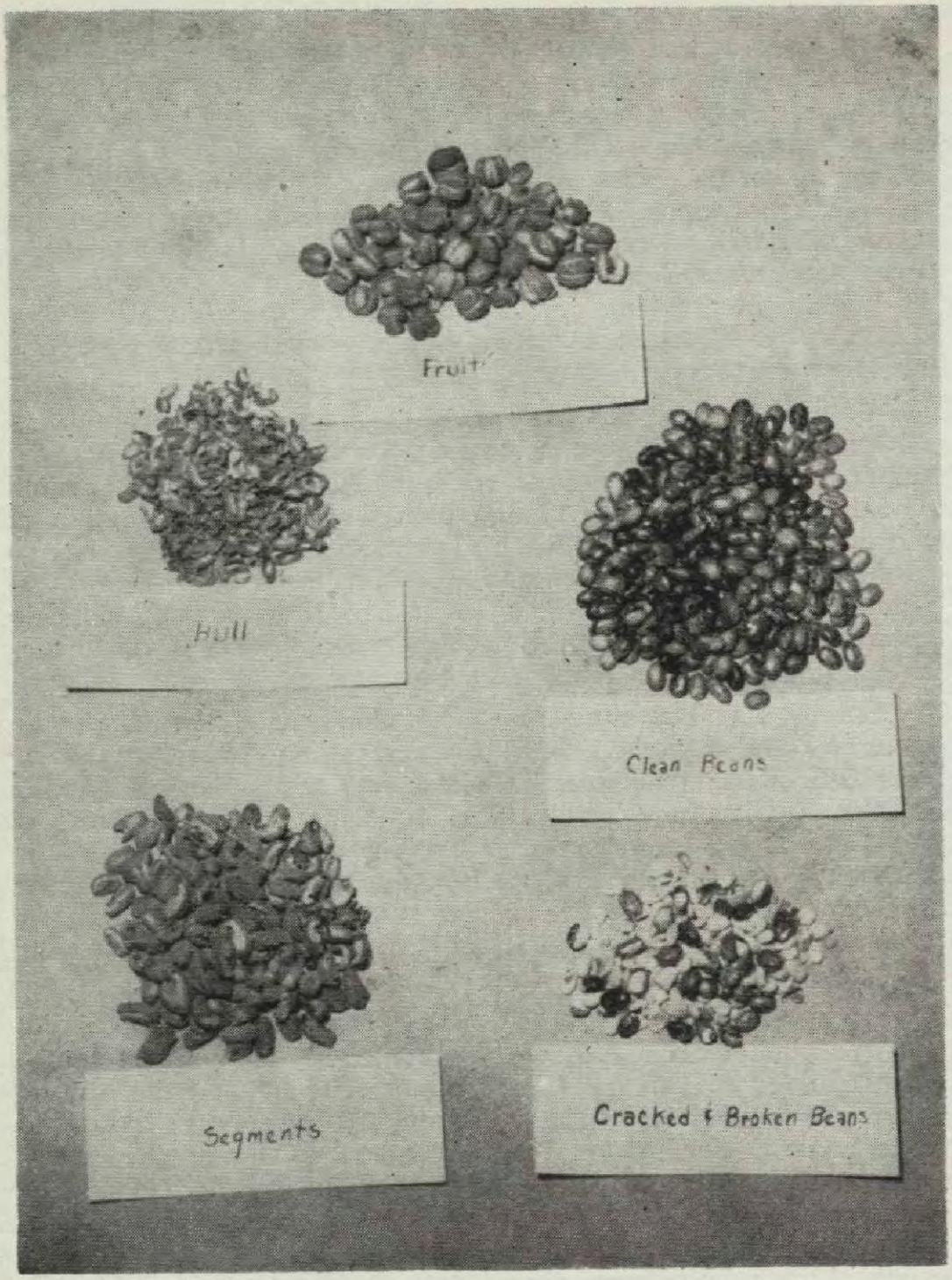


Figure 12.

Close up of the fruit and the products of the sheller.

During the various times that the sheller was used to shell castor beans, it was noted that a few of the beans lodged in the space formed between the edges of the adjacent rubber facings. This was especially true where the edges did not fit very well. Such beans so lodged were responsible for increasing the per cent of the broken beans at certain times and for increasing the segments at other times. This, of course, depended upon whether the beans provided a wedging action in increasing the clearance between the concave and the cylinder when the fruit was fed into the hulling area, or whether they provided more friction than was provided by the surfaces of the concave and cylinder, thereby introducing uneven hulling.

Uneven feeding was also noted to affect the efficiency of the sheller. It was found that at times more fruit would fall into the hulling area from the hopper so that either more friction would be created (two capsules finding their way into the hulling area and fitting side by side between the concave and cylinder), or due to the wedging action created between the concave and the cylinder uneven hulling would result. The slide gate provided to control the bottom opening of the hopper was found unsatisfactory in eliminating uneven feeding of the capsules into the sheller.

Shortly after his return from the United States, the author built a castor bean sheller while teaching at Jimma Agricultural Technical School using his previous work at Kansas State University as a guide. The new sheller was almost an exact duplicate of the previous one with the exception of the material used. The cylinder of the sheller was made from eucalyptus while the frames, adjusting members, and the concave were made from zigba. The rubber facing used was cut from old automobile tires. Instead of wood screws, nails were used to fasten the rubber facing on to the concave and cylinder.

This sheller gave the same results in shelling beans as the one that was built in the United States. The feeding mechanism that was provided (exactly like the one of the previous one) was found to be unsatisfactory. The addition of ball bearings at each end of the shaft improved the turning of the cylinder. Placement of the rubber facing on the cylinder was varied from the previous one in that the spiral method of placing one long piece all the length of the cylinder was abandoned and short pieces the length of the diameter of the cylinder were used. Each piece has its ends meet flush around the cylinder and the uncovered portion of the cylinder was likewise covered with other similar short pieces.

The first and the second shellers were constructed with the idea that separation of the hull and clean beans would be possible using the winnowing method ordinarily used by the Ethiopian farmers and therefore a mechanical means of separating the hull and the clean beans was purposely omitted. This was done

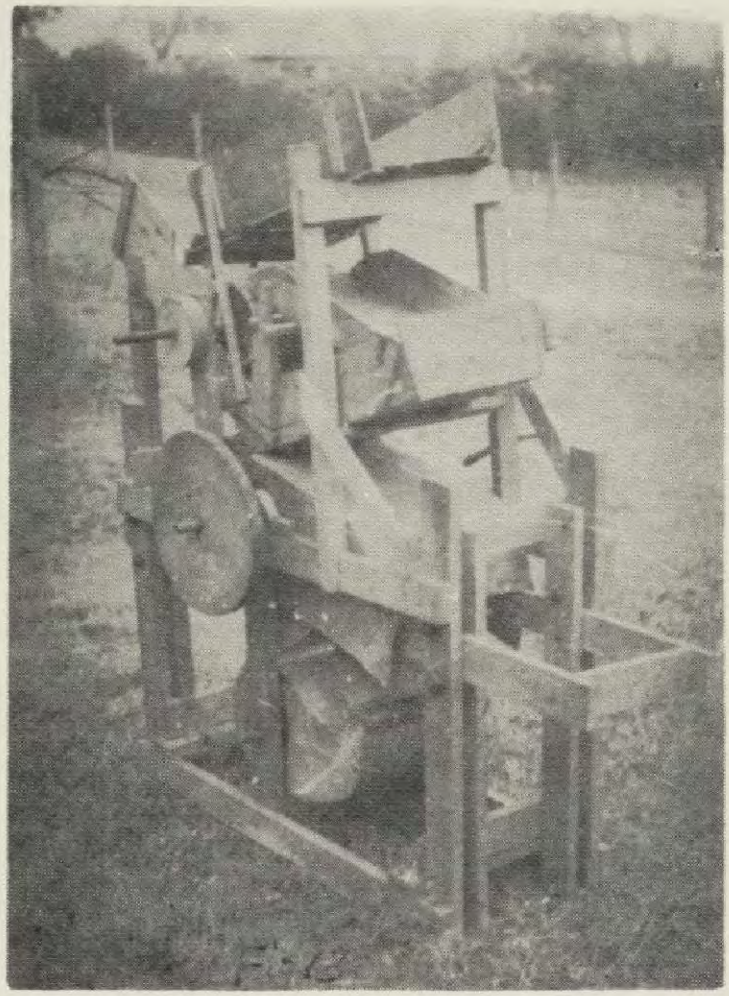


Figure 13.
A view of the sheller showing the fan housing and parts of the mechanical feeder

to reduce the cost of the machine. However, another sheller smaller in size and consisting of such accessories as the fan and its housing and mechanical feeder was built. This sheller was intended to facilitate even feeding and separation of clean beans and the undesirable parts. (Fig. 13).

The feeding mechanism consists of four boxes with one above the other and with different inclination. The uppermost and lower most boxes were kept fixed in place. Two of the lower most boxes meet at the entrance to the hulling area. Another box above these two is made to operate on a pivot to receive some beans that might otherwise fall outside (Fig. 14). This box plays up and down and this is made possible by a cylinder with a 5 cm projection of two boards above its surface and its whole length. The projection boards form a groove and one of them is purposely made slightly higher than the other. The board with slightly more pro-

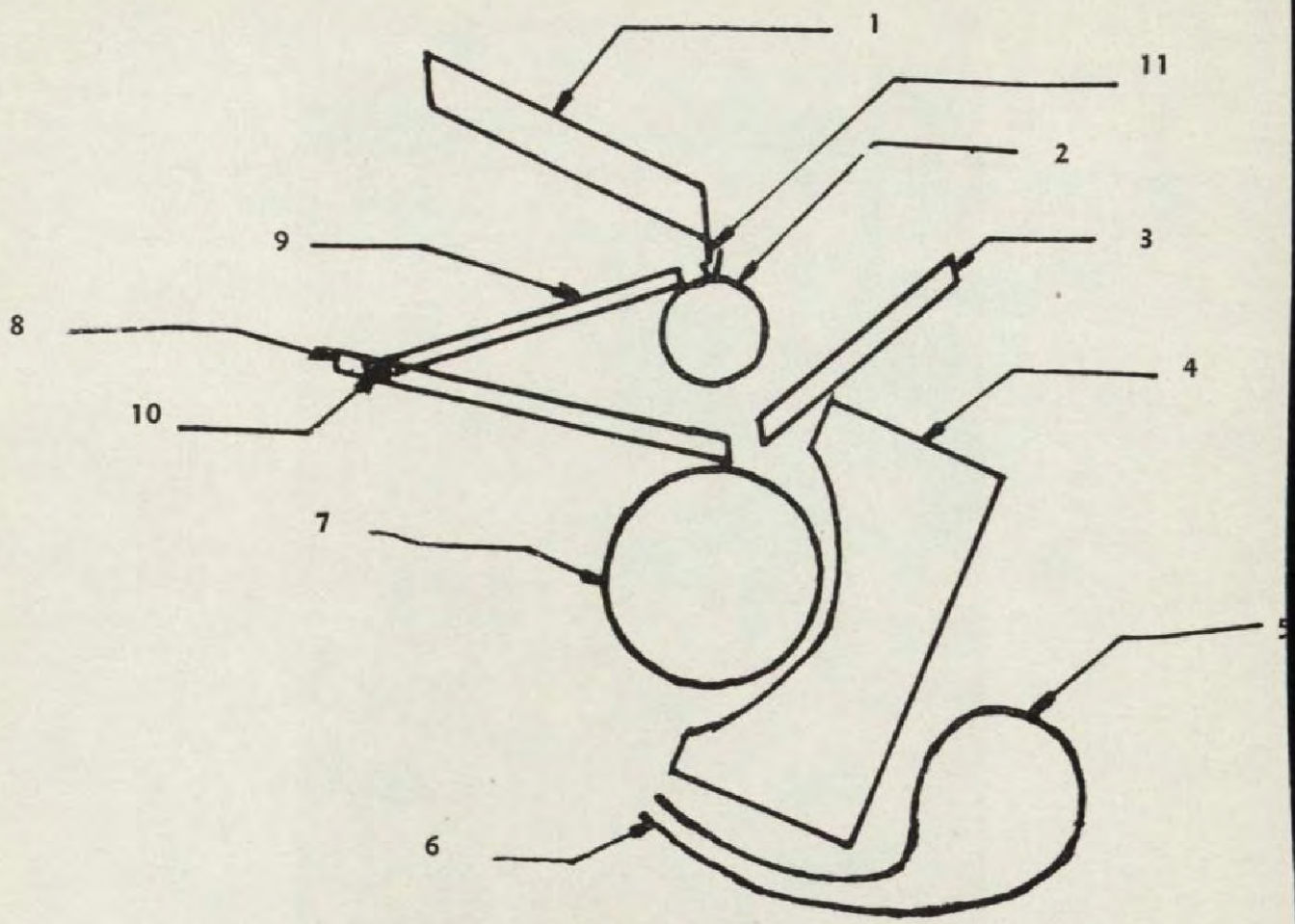


Figure 14.

A sketch showing the feeding mechanism and the fan housing in detail. 1. A box containing fruit to be hulled. 2. Cylinder with projections to open the control gate. 3. A box directing beans to the shelling area. 4. The concave. 5. Fan Housing. 6. Air channel. 7. The cylinder. 8. A box for directing extra beans to the shelling area. 9. A box for receiving extra beans. 10. A pivot. 11. Control gate.

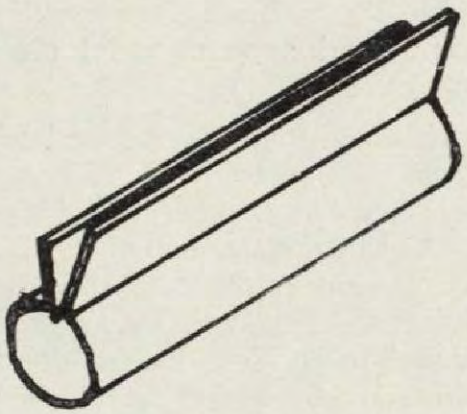


Figure 15.

The cylinder with the projecting boards forming a groove.

jection lifts the box fixed on a pivot during every revolution of the cylinder (Fig. 15). Furthermore this same board opens the hinged gate of the uppermost box containing beans to be hulled. When the gate opens the beans fall into the groove formed by the two projecting boards which are responsible for transporting the beans to the hulling area. The groove is made to hold only a single row of beans its entire length and extra beans that may pile on top of the single row of beans is readily removed by the hinged gate onto the box on a pivot. The cylinder is driven by a belt from the main cylinder.

A home-made fan was attached to the sheller in order to facilitate separation of clean beans from the hull. The power to operate the fan was obtained from the main cylinder. A tachometer reading showed an R.P.M. of 100 for the cylinder. The pulley of the main cylinder and that of the fan had a ratio of 4 to 1. This means that the R.P.M. for the fan would be 400 R.P.M. During the operation of the sheller, it was found necessary to increase the R.P.M. of the fan to facilitate separation. Moreover, it was found necessary to redesign the fan for better performance.

Figure 16.
A view showing a castor bean sheller built at Chiaffa Farm in operation.

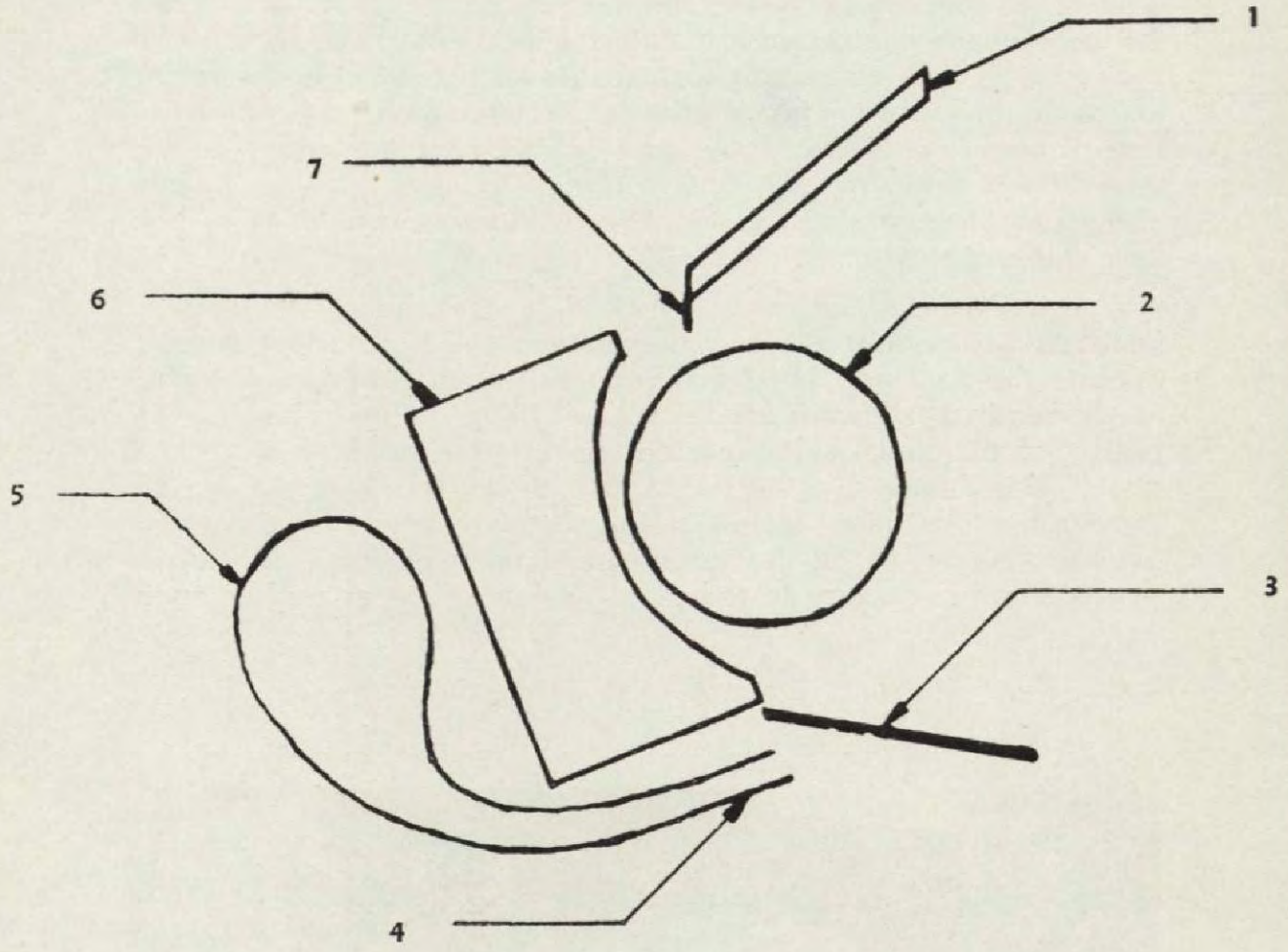


Figure 17.

A sketch showing detailed parts of the sheller built at Chiaffa Farm.

1. Feeder box containing fruit to be hulled. 2. The cylnider. 3. Screen to separate the beans and the hull. 4. Air channel. 5. Fan housing. 6. The concave. 7. Control gate.

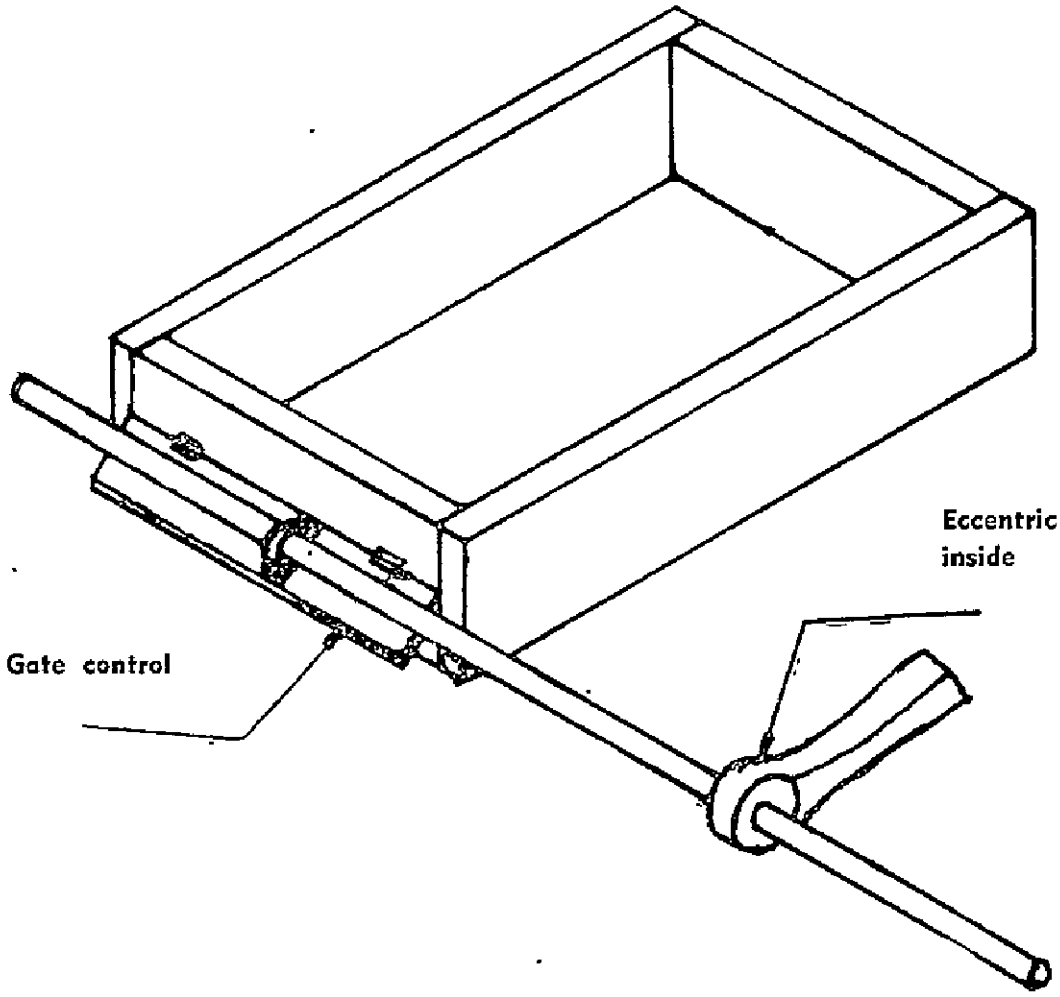


Figure 18.

A sketch showing the feeding mechanism of the sheller built at Chiaffa Farm.

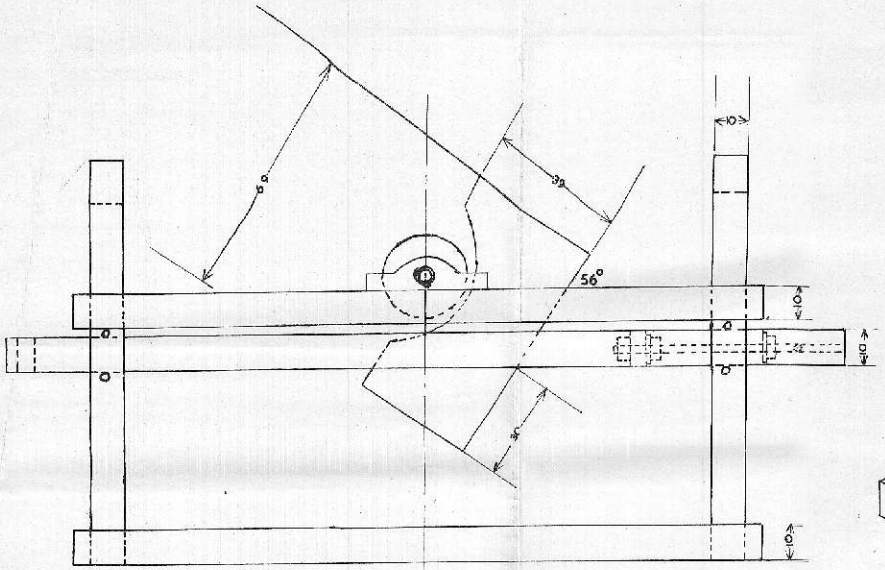
CONCLUSION

The uniqueness of the castor bean molecule will further capture the attention of the scientist in his search for new products. Moreover, as a material that does not have a better substitute so far existing, the castor will be in greater demand in years to come. This is specially true as its peacetime use would come to greatly surpass its wartime demands. This increasing demand will motivate the potential countries to produce it on a larger scale. Ethiopia as a country having the potential to produce more castor beans, will face a greater need for castor bean shelling machines. This can only be met by laying the foundation in advance. The presently suggested castor bean sheller, possessing all the qualities meeting the present day demand, can serve as a stepping stone to shellers of more complex design and higher efficiency.

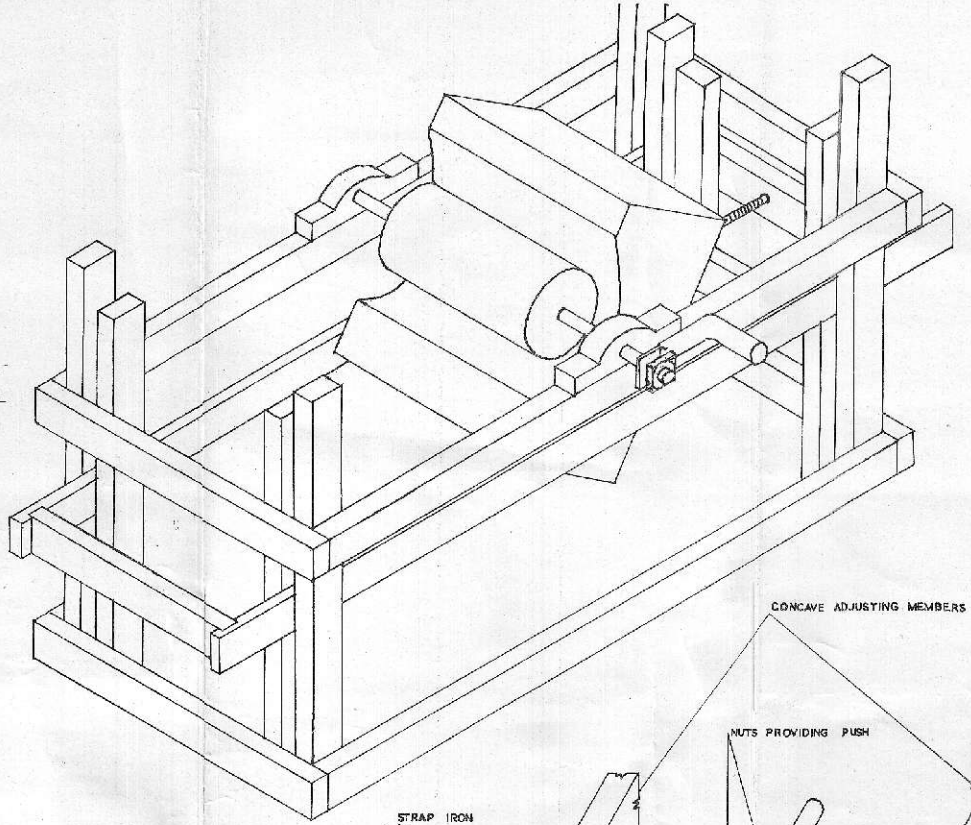
The present day needs of the Ethiopian farmer can be satisfactorily met by this machine. Its adaptability to the economy of the farmer, skill, and his available power make it of some significance to him.

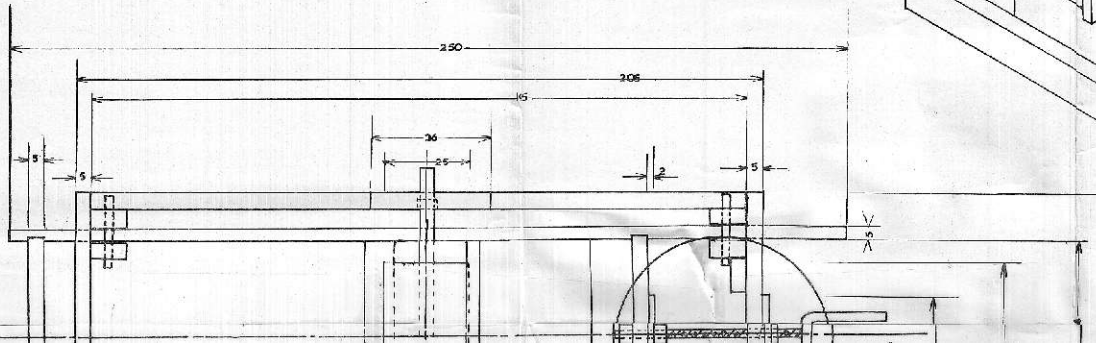
The shellers described in this publication were built by people possessing only a fair degree of skill. A great deal of improvement can be made in the performance of the sheller, if it is constructed by skilled people. This is further demonstrated by the fact that a successful sheller has already been built with the sheller developed by the author as a model. The Chiaffa Farm produced several tons of castor beans and was faced with lack of a sheller. The manager of the farm went to the Jimma Agricultural Technical School and took pictures of the sheller developed by the author and had sheller shown in Fig. 16 built. This sheller is built from steel except for the concave and cylinder portion which are made from wood. It is operated by a 2.5 H.P. electric motor and has an output of 2.5 to 3 quintals of beans per hour. It consists of the fan, feeding mechanism, adjusting mechanisms, concave, cylinder and screen to facilitate separation of the beans and the hull. Figures 17 and 18 show the details of the same machine.

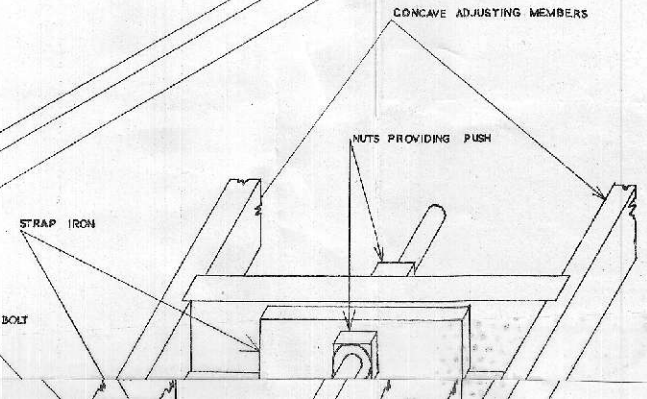
The present problems of producing castor beans in Ethiopia can be overcome partly because the Ethiopian farmers need no longer suffer from lack of a sheller. Successful and economical shellers have and can be built by following the plans and procedures presented in this publication.


56°
10
10
10

ELEVATION




250
205
15
36
25
5
5
5
2


CONCAVE ADJUSTING MEMBERS
NUTS PROVIDING PUSH
STRAP IRON
SCREW BOLT